GENESIS: GPS Environmental & Earth Science Information System

Tom Yunck, Richard Borgen, Jinbo Chen, George Hajj,
Rob Kursinski, Ken Lam, Rosanna Sumagaysay
Jet Propulsion Laboratory
California Institute of Technology

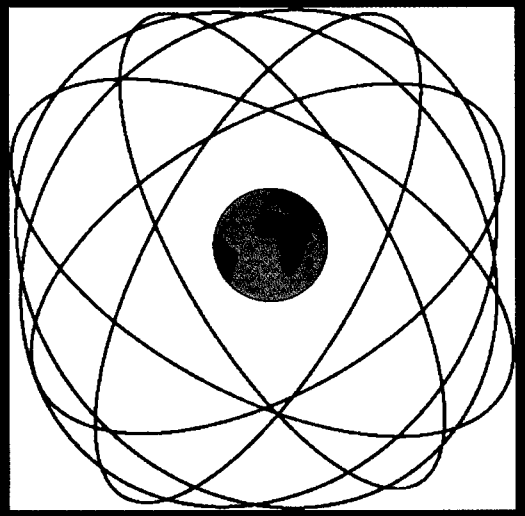
Cyrus Shahabi
Integrated Media Systems Center
The University of Southern California

ESIP-2 Technology Review
Greenbelt, Maryland
9 June 2000

Target User Communities

Climate Research
Weather Prediction
Atmospheric Science
Ionospheric Science
Global Geodesy

27 GPS Sats



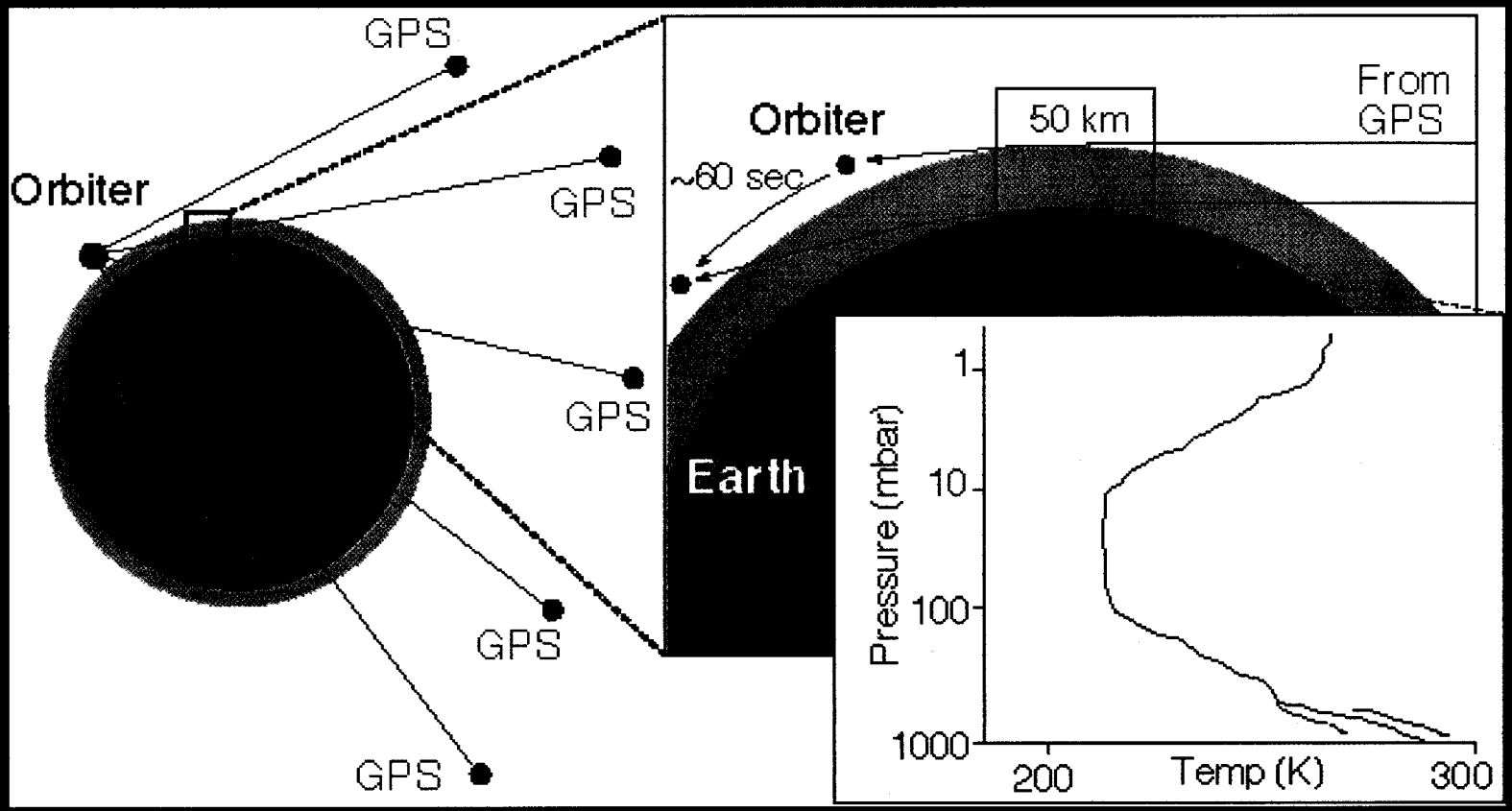
NASA LEO Array

Ørsted, Sunsat
Champ, SAC-C,
GRACE

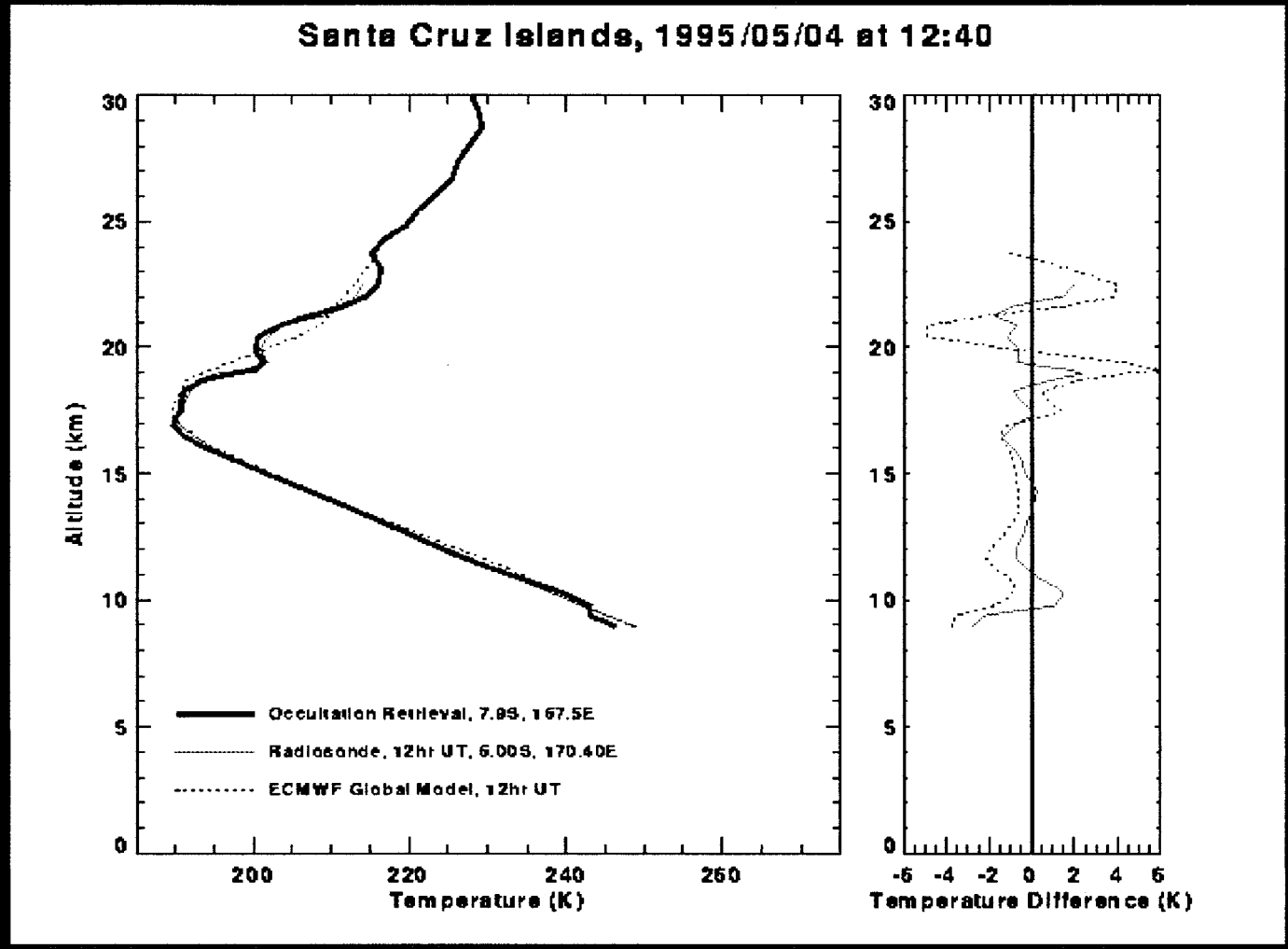
GENESIS Partners

JPL (Project Lead)
USC/IMSC (Info Systems Lead)
USC/ISI (Info Systems Support)
Univ. of Wisc. (Science & IT)

ATMOSPHERIC TEMPERATURE PROFILING WITH GPS LIMB-SOUNDING



ESIP-2 Technology Review: GENESIS



Conditions of GENESIS Development

No existing NASA flight data at the outset

No existing data system at the outset

Emphasis has been to assemble a simple, functional GPS DIS quickly, then add functionality and advanced technology

Principal User Needs

Obtain quality GPS occultation products

Understand how to use those products

Key Technical Challenges

Providing adequate product quality control

Providing timely product delivery

Providing tools and techniques for employing novel GPS products in traditional climate research

GENESIS Atmospheric Products

- Profiles of atmospheric bending, refractivity, density, pressure, temperature, moisture, geopotential height
- User-specified time and spatial averages of these
- Global pressure contours, gradients, derived winds
- Tropopause and boundary layer heights

Planned Tools & User Services

- Versatile search and query across data centers
- Data subscription: automated notification & delivery
- Data visualization tools
- Downloadable science analysis tools
- Experimental "data mining" functions
- User-contributed products and tools
- Information: tutorials, papers, FAQs

Key Properties of GENESIS Data

- All-new atmospheric data types: bending angle or refractivity can be directly assimilated into GCMs
- Rapid global coverage with small constellation
- Geometry complements ground & nadir sensors
- Exceptional accuracy: 0.1% refractivity; <0.5 K Temp
- Exceptional vertical resolution: few-hundred meters
- Each measurement is fully self-calibrating:
  - Data are virtually unbiased
  - Good long-term averaging (~10^{-4} refrac; <0.1 K)
  - All measurements directly comparable for all time
- All-weather: insensitive to clouds, precip, aerosols
- Independent height & pressure/temperature data
  - Yields geopotential heights and wind fields

Technology Innovation

Versions 1 & 2: adapt existing file-based technologies for rapid implementation

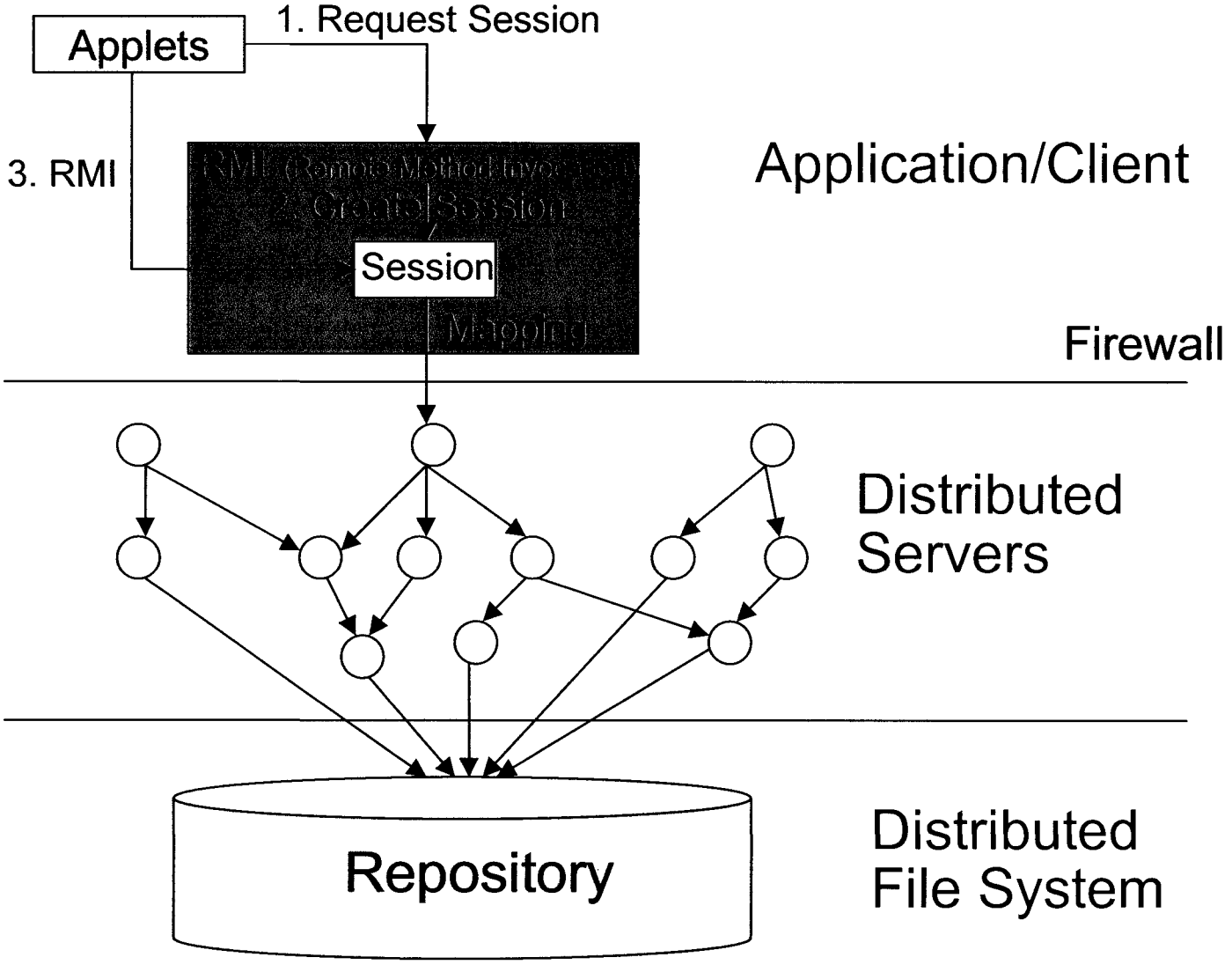
Versions 3 & 4: will incorporate advanced features (e.g., visualization, data mining) under development at USC and JPL

Principal Bottlenecks: obtaining data from S/C and generating level 1 data (outside of GENESIS)

Baseline GENESIS System at JPL

- V1.0 adapted from JPL's Distributed Object Manager
- Client-server design
- Distributed data catalogs and servers
- Product system based initially on file management
- Adopts Hierarchical Data Format (HDF-EOS)
- Supports standard HDF-EOS client tools
- Accessed using DIAL, Java GUI, Web, ...
- Web-based interface emphasizes Java applets
- Metadata is human-readable, machine parseable
- Allows versatile subsetting and user-specified actions
- DIAL integration into DOM virtually completed
- Advanced developments underway at USC/IMSC

Distributed Object Manager Architecture



GENESIS & Federation Activities

- Partnership established with GFZ in Potsdam to build compatible data systems for GPS science data
- Science collaboration begun with ESP2NET
  - Analysis and data manipulation tool development;
  - Cal-Val of operational passive sounders with GPS data;
  - Assimilation of GPS data into weather analyses;
  - Quantify "Pineapple Express" relating tropical convection to rainfall and water vapor in mid-latitudes;
  - Exploit unique GPS accuracy and resolution to study climate variability, e.g., Arctic, Antarctic oscillations.
- Participant in the ESIP Climate Cluster
- Extensive ongoing science interactions with climate and meteorological research groups worldwide

Interoperability Strategies

- Produce Occultation Products in HDF
- Capture metadata in HDF labels
- Conform metadata to EOS guidelines
- Use DIAL HDF Browser
- Use DIAL Global Map Query I/F

Interoperability Progress to Date

- Defined major HDF products: L1A, L1B, L2
- Defined complete EOS metadata for all
- Completing HDF production system
- Configured DOM catalog system for full metadata search & HDF repository
- Deployed Java catalog interface as a download application plus as applet via web browsers
- Testing DIAL capabilities

GENESIS Implementation Schedule